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FLOW OF TECHNOLOGY FROM THE OECD TO THE U.S.S.R: A FEASIBILITY --ETC(U)
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FLOW OF TECHNOLOGY FROM
THE OECD TO THE U.S.S.R.

A Feasibility Study

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I. Summary of Objective and Conclusions

This report (1) evaluates the feasibility for conducting a study of the relative value to the U.S.S.R. of technology obtained by direct exchanges with the U.S., and (2) discusses the availability, accessibility, and probable contribution of published and unpublished sources of information and data necessary to carrying out the project.

Our conclusion is that the basic objective is indeed feasible, and the originally proposed program of value, for these reasons:

- (1) Adequate information is, or will be made, available,
- (2) The specific analysis recommended has not been previously performed.
- (3) Current research programs at other institutions are not addressing these specific questions, *etc.*
- (4) The results will provide a valuable basis for broader discussions and analyses.

II. Basis of Research Program

A research program has been submitted to the Department of State requesting support for a particular evaluation of technical exchanges between the U.S. and the U.S.S.R. The question addressed in that proposal was: How valuable are those technical exchanges to the U.S.S.R.?

There is no quantitative answer to this question. Qualitatively, there are two aspects to the "value" involved:

- (1) What is the intrinsic value of the technology available to the U.S.S.R. from the U.S.?
- (2) How effectively can the U.S.S.R. exploit the potential value of each technical area of concern?

This program is not concerned directly with the second question of effective

use within the U.S.S.R. Even the first question is complex, since it involves not only the technical significance of a particular exchange, but also the economic implications and, possibly, in specific cases, political implications.

The principal focus of this program is intended to be on the technological significance of the technology exchanges that occur via various mechanisms. In the course of analyzing such technical significance, it is probable that there will be additional insights gained as to economic or political values, and of the U.S.S.R. capabilities for exploiting specific areas. Nevertheless, the program will concentrate on the technology per se.

It is believed that this emphasis will provide a uniqueness and perspective that has not been understood clearly, as evidenced by the published articles dealing with these exchanges. First, there exist many centers of competence studying the economic and political aspects of the technology exchanges, and there are additional centers and individuals knowledgeable about Soviet abilities within specific technical areas and industrial sectors. Hence, any direct attempts to emphasize these areas would simply be one modest addition to an already sizeable effort. (See Section IV.A.1 for a listing of the most important published literature in this area.) Second, much of the technology exchanges, perhaps most, are embodied in agreements between Soviet ministries and Western private firms rather than the bilateral agreements between governments or public exchanges involving academic research. While the subjects of such exchanges are generally known and identified, the nature of the technology involved is often confusing at least to others than the immediate parties to the agreement. Third, there is a tendency in each country, particularly in the U.S., to concentrate on that country's own exchanges with the U.S.S.R. In actual fact, the U.S.S.R. is exposed to a world flow of technology, which is often minimized in U.S. policy considerations.

Specifically, then, the uniqueness of the research program submitted to the Department of State lies in addressing the three points above:

- (1) The research will include judgments as to the technical "status" of a particular technology exchanged, in terms of the state of the art in that field, its position in the chain from laboratory research to useful product or process, and so on.
- (2) The major part of the effort will be devoted to industrial exchanges and will seek to identify and evaluate technology involved in overall business and manufacturing agreements, as well as explicitly stated technology exchanges.
- (3) The truly critical evaluation of any technology exchange will be the comparison of that item or procedure available to the U.S.S.R. from another OECD country.

The ability to proceed effectively with this program rests upon certain assumptions as to the availability of the data, the willingness of industrial companies to provide adequate information about the nature of the technology involved without touching on proprietary information, and the cooperation of individuals in all sectors in providing the judgments required to evaluate a specific U.S. technology relative to comparable foreign technology.

At the request of the Department of State, a short feasibility study was initiated to review quickly the types of data available, their probable usefulness, and to include at least one case study of a specific industrial exchange.

Section III of this report outlines the basic methodology to be used in the proposed study. Sections IV and V review the published and unpublished sources of information, respectively, relating to determining the feasibility of the project. Conclusions as to feasibility are presented in Section VI.

III. Research Methodology

In this project we propose to select a small number of industrial sectors for indepth study. A four-step screening procedure will be used in the selection of these sectors. The first step will involve the identification of Soviet priority areas, in terms of Soviet economic and science and technology (S&T) development objectives. Soviet priority sectors can be identified by a thorough examination of available economic and technical literature (see section IV. A.1), and discussions with knowledgeable Western analysts and officials. We do not expect, of course, to develop a precise ranking of sectors. Instead, our objective will be to ensure that we are investigating S&T exchanges involving a sample of sectors which are among those of highest priority in the view of the Soviet economic and technical leadership.

Second, from among these priority areas a list of individual sectors will be developed on the basis of whether there has been or will be a particular Soviet need for technology imported from the OECD, and from the United States in particular. In part, of course, this is a question of the degree to which Soviet science and technology "lags" behind that of the West. There is already a sizable literature on this issue (see section IV. A.1). Trends in the pattern of Soviet import needs (e.g., from the OECD as opposed to CMEA countries) can be roughly characterized on the basis of a number of studies of existing forms of East-West "industrial cooperation" and S&T exchanges (see sections IV. A.2 and IV. B). Furthermore, we plan to undertake our own more formal, empirical study of OECD exports of products embodying high technology with the purpose of demonstrating (a) the changing geographical pattern of Soviet "embodied technology" imports, (b) the changing pattern of apparent U.S. leads in "high-technology" products in world trade more generally, and (c) the changing U.S. share of exports of high-technology exports to the USSR, with

some formal attempt to explain these shifts. The methodology for this part of the project is briefly outlined in Appendix A.

A third criterion will be evidence of a possible U.S. lead in one or more forms of technology within a sector. In effect, we want to focus on those sectors for which we have reason to expect that U.S. firms may have some potential for "unique" S&T transfers to the Soviet Union. Evidence with respect to this criterion will be drawn from some of the literature listed in sections IV.A. and IV.B. and from the statistical investigation of the changing pattern of U.S. market-shares in technology-intensive products in world trade. (See Appendix A for a more detailed discussion.)

The final criterion for selection of individual sectors will be whether the investigators have sufficient access to private sources in a particular sector, in order to carry out the interviews necessary to evaluate current and prospective S&T exchanges. The nature of the personal contacts that are necessary, and the types of information which we believe can be obtained through these informal contacts, are discussed in some detail in section V, based on some preliminary discussions with individuals in the aluminum industry.

For each of the sectors that pass this four-step test, we will attempt to answer the following basic questions:

- (1) Do U.S. firms have the potential for scientific and technical exchanges with the Soviets that are in some sense unique; i.e., that cannot be matched by other OECD countries?
 - (a) If U.S. firms do possess some unique S&T exchange potential, what precisely is the nature of their lead?
 - (b) Is this lead increasing, or diminishing over time?
- (2) In a particular sector, or with respect to a certain type of technology,

to what extent are the Soviets willing to trade-off, in their negotiations with potential Western suppliers, between technological level and other factors such as (a) price, (b) availability of credits, (c) ability of the supplier to "manage" large, complex projects, (d) the unpredictability of the export control procedure in the supplier company's home country, etc.? (I.e., how inelastic is Soviet demand for the most advanced technology?)

- (3) What is the overall competitive position of the U.S. firms, vis a vis their OECD counterparts, when all or some of the above factors are taken into account?

Our answers to these questions will be based on our evaluation of information from three sources: (1) interviews with government, technical ministry, and industry officials involved with each industry sector (in several countries), (2) sector "experts" who will be commissioned to prepare reports on the industry "state of the art" and comparative S&T levels, and (3) the detailed empirical study of "high technology" products described in Appendix A.

The objectives of this project are limited to attempting to answer the basic three questions. We will not attempt to speculate on the actual or potential Soviet success in assimilating and diffusing the S&T transferred in the individual sectors. There already exists a fairly substantial, and growing, literature on the issue of Soviet S&T absorption and diffusion more generally and in specific sectors (see section IV. A.1).

We will also not attempt to speculate about whether all S&T exchanges by U.S.-based multinational corporations, to the extent that such exchanges include technical documentation or technology embodied in products, necessarily fall within the purview of the unilateral export control program of the United States. Whether a particular instance of technology transfer is "controllable"

unilaterally by U.S. authorities is a technical matter subject to interpretation of the Commodity Control List by the appropriate officials of the U.S. Government. More generally, we will not seek to delineate the potential for "control" of specific S&T exchanges.

Finally, the goal of the project is limited to making an objective evaluation of the relative uniqueness of U.S. technology ((1) above) and the context of this uniqueness ((2) and (3)). Whether the approval or denial of permission for exchange of such technology would be an effective instrument of U.S. foreign policy is a question appropriately left to others.

As far as we can determine, the research objective and methodology of this study is unique. For a brief discussion of related, but as far as we can determine, not overlapping studies, see section IV.C.

IV. Review of Available Published Studies, Data Sources and Related Research Projects

Over the past several months, the investigators have undertaken a review of published information and data sources, as well as other ongoing projects, in order to: (1) Determine the feasibility of this proposed project, and (2) Ensure that the project will not needlessly duplicate what is being done elsewhere.

A. Available published studies

The past decade has witnessed a mushrooming of literature regarding Soviet science and technology and East-West S&T exchanges. Those published or soon-to-be published studies most relevant to our project are usefully bracketed under the following categories. Most of the cited literature is the product of Western economic and technical analysts.

1. Studies of Soviet science and technology and particular industrial sectors. (i.e., the "demand" side for purposes of our project).

a. Soviet S&T levels and lag behind the West.

Useful information and evaluations regarding the relative strength of Soviet S&T in various individual sectors is to be found in Boretsky (1966), Amann et al (1977), Wilczynski (1974), Sutton (3 vols., 1968-73), Perakh (1976), Slama and Vogel (1975, 1976), Judy (1970), Fink (1971), and Campbell (1976a, 1976b, 1976c).

b. Soviet S&T absorption, diffusion, and impact studies.

A number of studies have appeared in the past 4-5 years which investigate Soviet abilities to assimilate Western technology and the impact of imported S&T on the Soviet economy. Among the most important studies which attempt to gauge the impact of Western technology on the Soviet economy or on individual sectors are Hanson (1980), Levine et al (1976), Green and Levine (1976), Weitzman (1979), and CIA (October, 1978). Important examinations of assimilation and/or diffusion include Amann et al (1977), Hanson (1976a, 1976b), Perakh (1976), Hardt (1976), Hilliday (1979), Hanson and Hill (1978, 1979) and Vogel (forthcoming). Authoritative examinations of Soviet capacities for innovation are Berliner (1976a, 1976b). A recent study by Martens and Young (1979) examines the implementation and diffusion of indigenous Soviet technological advances.

c. General studies of particular sectors

Other analysts have focused on general economic and technical developments within entire industrial sectors in the Soviet Union. Among other benefits of their studies are statistical series regarding domestic production and import trends, often disaggregated by approximate technological levels. These sector studies include the Soviet oil and gas industry (Campbell, 1976a, 1976b and 1976c), cement industry (Abouchar, 1976), tractors (Rubenking, 1976), machine tools (Grant, 1979), chemical fertilizers (Hanson, 1980), computers (Tasky,

1979; Goodman, 1979) and computer software (Goodman, 1978 and 1979).

d. Soviet demand for Western S&T.

There are fewer useful studies that focus particularly on Soviet demand for Western science and technology, although many of the above-mentioned studies do devote some attention to the issue. Literature with this focus includes Hardt (1976), Rushing and Liberman (1976) and to some extent Hanson (1978, 1980), Beitel (1976), Tasky (1979) and Grant (1979).

2. Studies of East-West trade S&T exchanges.

Aside from the literature focusing primarily on the Soviet, or "demand" side, there is a rapidly growing number of studies focusing on the East-West nexus (in effect, on the interaction of Soviet "demand" and Western "supply" factors).

a. Analyses of East-West trade flows and market-shares

One body of literature has focused on the determination of individual OECD country (and particularly, U.S.) shares of the Soviet export market. Given the importance of technology in Soviet imports from the West (well-documented in such studies as Zaleski (1979) and Kravalis et al (1979)), these trade share studies have an obvious relevance to the issue of relative U.S. technological advantages in East-West trade. Basic trade share studies, now a bit dated both in terms of methodology and time period examined, include Montias (1971), Brada and Wipf (1974), and Wolf (1972, 1973, 1977). A survey of this early literature appears in Wolf (1975).

b. Studies of the nature and economic effects of East-West industrial cooperation and eastward technology transfer.

In varying degrees, this growing literature deals with such issues as the types of technology being transferred, the economic basis of such exchanges, the sources (mechanisms) of transfer, and the immediate economic effects of such exchanges on both eastern and western partners. Only a few studies focus

on exchanges with the USSR per se.

Among the more useful studies are Kravalis et al (1979), Zaleski (1979), Altmann and Clement (1979), Thomas and Kruse-Vaucienne (1977), Beitel (1976), Mathieson (1979), Levick and Stankovsky (1979), Bolz (1976), Bolz and Ploetz (1974), Baufeldt (1978), Wilczynski (1974), Levine et al (1976), Marer and Tabczynski (1980), Marer et al (1975), Hewett (1975), and Committee on Science and Technology (1979).

c. Analyses of the problems involved in East-West S&T exchanges.

A number of useful studies have examined various technical, managerial and economic problems (as well as benefits) involved in East-West technology transfer. These include various contributions in Thomas and Kruse-Vaucienne (1977), Bolz and Ploetz (1974), Marer et al (1975), Marer and Tabaczynski (1980), Vernon and Goldman (1974), Hayden (1976), Mathieson (1979), Brada (1979, 1980), and Wolf (1978).

d. Evaluation of S&T exchanges.

In the past few years several studies have attempted to delineate the extent of, and have sought to evaluate, S&T exchanges with the Soviet Union not involving the direct export of proprietary technical documentation or products embodying advanced technology. These studies include Theriot (1976), National Research Council (1977a, 1977b), and Rushing and Ailes (1979).

3. Studies of comparative technological levels within the OECD countries ((OC)--i.e. the "supply" side), and intra-firm technological transfer.

There of course exist studies of comparative technological levels within the OC and of intra-firm (MNC) technological transfers. These include OECD (1970), Behrman and Wallender (1976) and Baranson (1976, 1978). To our knowledge, however, there do not exist studies which focus specifically on comparative technological levels in sectors of particular interest to the U.S.S.R.

In summary, there is now a vast literature concerned with various aspects of S&T exchanges with the Soviet Union and the CMEA countries more generally. Much of this literature will be useful to us in selecting a sample of individual sectors for intensive analysis, according to the first and second criteria discussed in section III (Soviet priorities and Soviet needs). Compared to the rapidly growing literature that is concerned with Soviet science and technology and East-West S&T exchanges, however, there is a relative dearth

of published information regarding the "supply side" in the eastward flow of technology. This is a gap which the proposed project is intended partially to fill.

B. Data Sources

Published data, whether regarding patents and licenses or trade flows "embodying" some degree of advanced technology, obviously cannot be expected to yield any precise measure of technology flows. But as already pointed out, such data will be useful in (1) helping us to select appropriate sectors for study, and (2) providing a rough check on our conclusions regarding the relative uniqueness of U.S. technology in individual sectors.

Fairly aggregated statistics on East-West "technology" trade flows and patent applications are available from various Economic Commission for Europe (ECE) documents, presumably in a forthcoming study of East-West technology transfer by the OECD, and in such specific studies as Mathieson's (1979) investigation of Japanese S&T exchanges with the Soviet Union.

Existing studies of East-West industrial cooperation (which usually involves some type of technology transfer) also contain tabular material potentially useful for making comparisons of industrial cooperation (IC) involvement with the USSR by (1) industry sector and (2) Western country, including the United States. Of particular use in this regard are various studies by the ECE, presumably the forthcoming OECD report, Marer et al (1975), Levchik and Stankovsky (1979) and Altmann and Clement (1979).

Those aforementioned studies which attempt to gauge the degree of "embodied" high technology trade flows to the USSR are also useful sources of statistical compilations. These studies include Kravalis et al (1979), Zaleski (1979), and Beitel (1976). Given the comparative (U.S. versus other OECD countries) thrust of our own work, other studies, such as an unpublished report

by Bureau of East-West Trade (BEWT) staff on the effect of foreign affiliates on U.S. export market-shares in the USSR, may also be useful.

Finally, our interest in defining Soviet S&T priority-need areas suggests that we can profitably use data generated by earlier studies which measured the degree of Soviet dependence on imports from the OECD countries, by major industrial sector. These studies include Bolz (1976) and Zaleski (1979). These data need to be updated, however, and we are particularly interested in tracking this degree of dependence over time, using annual issues of Vneshniaia Torgovlia SSSR. One of the problems with Soviet foreign trade statistics, of course, is their relatively high level of aggregation. When making OECD-CMEA comparisons, this problem cannot be circumvented. Much more disaggregated analysis is possible, however, in the case of changing product and trade-partner patterns among OECD exporters, using OECD Series C Trade by Commodities and possibly the statistical tapes maintained by BEWT.

In summary, these statistical measures of technology flows are in many cases highly aggregative and in any event imprecise. While not constituting a definitive measure of either changes in Soviet needs or differentiated Western technological capabilities (inasmuch as the actual, measured flows are the result of the interaction of a number of supply and demand factors), a careful statistical analysis will nevertheless provide a useful, indeed necessary, complement to the personal evaluations which we will solicit.

C. Related Projects

To our knowledge, there are six existing projects which are related to our proposed study.

1. University of Birmingham group

The group of scholars based at the Centre for Russian and East European Studies at the University of Birmingham (U.K.) is responsible for the authoritative

study of the technological level of Soviet industry contained in Amann et al (1977). Several scholars associated with this Centre are currently focusing on the impact of Soviet institutions and organization on the domestic innovation process within the USSR.

2. Office of Technology Assessment (OTA), U.S. Congress

The group concerned with "Technology and International Relations" within OTA has completed a general overview study of the various issues involved in East-West technology transfer. The final report (OTA, 1979), is a useful policy-oriented study which examines the economic, political and military aspects of U.S. and, more generally, OECD technology transfer to the communist countries.

This same group at OTA is also undertaking more indepth studies of the U.S. steel and electronics industries. The focus of these studies is apparently on the determinants of worldwide U.S. competitiveness in these industries. Similar studies may later be conducted for the chemicals and aerospace industries.

3. Organization for Economic Cooperation and Development (OECD), Directorate for Science Technology and Industry.

The OECD has been embarked on a large investigation of East-West technology transfer for the past several years. Relying for the most part on published sources, the project has apparently concentrated on the history of East-West technology transfer, a statistical overview of these exchanges, an analysis of different forms of transfer, policies, and the impact of these exchanges on both Eastern and Western countries. The final report has not yet been released for public distribution.

4. Department of Defense (DOD).

As is well-known, the DOD has initiated a program to develop a list of "militarily critical technologies" in the attempt to refine and strengthen U.S. export controls for "national security" purposes. A militarily critical

technology is defined as one that would make a significant contribution to the military potential of an adversary (i.e., reduce the U.S. leadtime).

Fifteen general "areas" of applied science or engineering have been identified as probably containing specific military critical technology products, transfer mechanisms and information over which DOD believes export controls are warranted. DOD is attempting to identify, in specific cases, modes and mechanisms for actual transfer and the controllable features of each technology (Davis, 1979).

5. Department of Commerce (DOC) - Department of State (DOS).

The DOC and DOS are currently carrying out, on a trial basis, a "Technology Transfer and Data Collection Program" by means of questionnaires at several diplomatic posts. A number of issues are the subject of analysis, but apparently the "relative uniqueness" of U.S. S&T is not one of them.

6. Stanford Research Institute (SRI).

Under contract to both DOC and DOS, the Stanford Research Institute has commissioned Philip Hanson and Malcolm Hill (University of Birmingham, U.K.) and Heinrich Vogel (Bundesinstitut fuer Ost-wissenschaftliche Studien, Cologne) to examine the experiences and judgments of British and West German exporters, respectively, regarding Soviet assimilation of Western technology. The findings of the unpublished Hanson and Hill study (1978) are summarized in Hanson and Hill (1979); the Vogel study is not yet available.

In summary, no existing study that we are aware of is looking in any detail at the issue which concerns us. It is possible that there may ultimately be some overlap between the DOD "critical technologies" project and our own, although the degree of possible overlap is virtually impossible to predict given the different objectives of the two studies and the difficulty, thus far, of evaluating the progress being made in the DOD program.

V. Available Material from Private Sources

A. Nature of Material

There have been, and continue to be, many exchanges of technology between industrial firms of the OECD countries (U.S., Europe, and Japan) and organizations within the U.S.S.R. (production ministries, State Committee for Science and Technology). These may be direct exchanges of non-confidential advances in a particular area such as welding research or magnetohydrodynamics, and such exchanges are at least easily identifiable. Additionally, any agreement that involves manufacturing operations such as the production of trucks or fertilizer, while it may be a straightforward installation of a turn-key plant incorporating known and proven procedures, almost inevitably involves some technological exchange of value to the U.S.S.R.

Each OECD country which has exchanges with the U.S.S.R. has one or more lists identifying all such exchanges in varying degree of completeness and depth. There are exchanges that are limited to discussions among selected individuals, possibly including seminars and conferences, which involve no physical transfer of reports or materials. Not all of these potentially valuable exchanges are listed as formal agreements even though they may constitute a continuing relationship between a private company and a Soviet ministry. Thus, many valuable areas of exchange are not referred to explicitly in official summaries.

Probably a more serious deficiency which this program intends to address is that of depth. This refers to evaluating the significance of any given technical exchange. It calls for the judgments of a technologically-oriented peer group, involved with either the generation or the use of comparable technology, usually from an industrial perspective.

Thus, the information sought in this program from the private sector will cover principal avenues for meaningful technical exchanges, will include all relevant OECD countries for the particular disciplines or industry sectors selected for in-depth study, and will draw on peer judgments on the significance of the selected technologies.

The comparative data from OECD countries and the peer judgments are more critical than completeness. At best, the program will be limited to a small number of fields or industries compatible with the funding. The fundamental objectives of this program can be served by sufficient analysis of a limited number of important fields. The evaluation of technological significance, specifically with regard to comparable efforts throughout OECD countries, adds an element of uniqueness to the program.

B. Discussion of Material

A number of representatives from major corporations in the U.S. and Europe have been contacted concerning the feasibility of carrying out the research called for in this program. High-level representatives of four OECD governments have also been contacted regarding their cooperation, particularly with regard to exchanges involving private companies of their countries with the U.S.S.R. In-depth discussions were held in one major European country with government personnel, and a specific case of one industrial exchange, aluminum technology, has been subjected to a comparative evaluation to test the cooperation of those involved.

Several general observations are possible from these contacts. American industrial representatives, primarily senior technical officers of large corporations, were very cooperative. They were willing to discuss in reasonable detail:

1. The extent of exchanges in the past or in progress with the U.S.S.R.
2. The relation of each exchange to the state of the art in that field.
3. Their opinion of the economic or commercial significance of the exchange to the U.S.S.R.
4. The probable effectiveness of the U.S.S.R. in putting the technology to use.
5. The availability of comparable technology in other OECD countries.

Undoubtedly, cooperation of U.S. personnel is explainable in part because of personal acquaintance, in part because the study is under the sponsorship of the U.S. Department of State. This is of particular importance since U.S. contacts will be critical in the peer groups that will be asked to place judgments on the technological significance of exchanges, including judgments on comparative technology available from other OECD countries.

One would expect somewhat more hesitation from European industrial representatives, and this expectation was borne out in an interesting way. A number of contacts were made with Europeans of equivalent status to the U.S. industrial personnel, and also of long-standing personal acquaintance. Each expressed the belief that it would be extremely difficult to get the kind of information and judgments about exchanges with the U.S.S.R. from European industry. Each then went on for an hour or more to discuss the experiences and future plans of his company in such exchanges, opinions about U.S.S.R. competence in that area, and so on. The only difference from the U.S. contacts was that the Americans assumed others would cooperate while the Europeans did not.

To test the nature of these conversations, information was provided by representatives of Pechiney-Ugine-Kuhlmann about a well-publicized agreement on exchanges in aluminum technology completed several years ago with the U.S.S.R.

Some minor items bringing the situation up-to-date may not be generally public. A statement of this current status, plus evaluations and judgments by others in the industry, are attached as Appendix B.

In this one area, there is some perspective provided as to the capabilities provided to the U.S.S.R., a sense of U.S. position vis-a-vis other countries, and the relative strength and effectiveness of the U.S.S.R. regarding aluminum technology. It appears to provide a basis for judging potential future U.S. exchanges with the U.S.S.R. in this area. Finally, it offers a reference point in evaluating the relative importance to the U.S.S.R. of aluminum technology available from the U.S.

There is a further item to consider. In the aluminum case, contacts were requested to put statements in writing. While each was told that his specific comments would not be attributed, one would have to assume that the writer would assume that his identity or affiliation could be guessed. Thus, the information obtained in writing is only a fraction of what is available in verbal contact. Undoubtedly, the most valuable judgments as to U.S.S.R. capabilities, future directions of U.S.S.R. and OECD technologies, and probable future exchanges can only be obtained verbally, then applying some discount factor depending on the person involved. The written comment will tend to represent the views of the industrial organization, the verbal one that of the individual.

There were also detailed discussions held on this subject with government representatives of one major European country. It was felt that this was an important factor in order that any private company representative could be assured of his own government's cooperation. There will be a basic hesitancy to overcome concerning the company's position about discussing exchanges with the U.S.S.R., without having a further uncertainty about the position of the individual's national government.

Again, the reaction resembled that of the European industrialists. During a meeting at the Foreign Ministry, all expressed the belief that there would be little cooperation from the private sector in discussing their exchanges with the U.S.S.R. However, the Foreign Ministry would be delighted to have the program succeed, and offered to cooperate in any way possible. Specifically, they will provide a list of companies in their country most active in exchanges with the U.S.S.R., and identify the general subject matter of each. We will review our intended interviews with them in advance, and they will help with contacts if we need them, and will provide assurances of their cooperation at our request.

In general, the Foreign Ministry did not know the technical details of industrial agreements, and was clearly not in a position to evaluate significance to the U.S.S.R. of a particular exchange or exchanges in general. They would be interested in our proposed study in general, and we have some obligation to provide them with deductions or comments on exchanges involving their private sector, sufficiently sanitized to meet our commitments to individuals. This could be accomplished with a copy of our final report plus personal discussions.

In fact, such follow-up discussions might offer an interesting basis for the cooperative involvement of appropriate representatives from the Department of State, thus providing interpretive discussions among counterparts with common interests in this subject.

VI. Conclusions

The examination of available publications, the survey of related research activities at other institutions, and discussions with industrial and government representatives have demonstrated to the investigators that it is indeed feasible to achieve the objective of the broad study proposed to the Department of State. Several detailed comments are called for to expand and clarify this general conclusion.

1. There is a considerable amount of available published material containing data on the nature and quantity of technology exchanges between the U.S.S.R. and OECD countries. Other relevant material is being generated by the OECD itself and by other current studies. Much of this data will aid in the selection of specific sectors for detailed study, and can provide perspective for evaluation of new data generated by the proposed study.
2. There is strong evidence of cooperation on the part of industrial representatives in the U.S. and other OECD countries in providing detailed, though not proprietary information on technology embodied in commercial agreements with the U.S.S.R. This includes a willingness to provide judgments on both the technical and economic implications of exchanges between the U.S.S.R. and any OECD source.
3. There is strong evidence of cooperation on the part of government officials in a number of the major OECD countries with regard to technical exchanges between the private sector of their countries and the U.S.S.R.
4. The published data do not focus on the comparative technology evaluations which is a principal objective of this study. There is a definite gap in past analyses of the "supply side" of technology flowing to the U.S.S.R. in this regard.
5. Further perspectives on comparative technological values can be provided by careful statistical analyses of changing technology flow between the U.S.S.R. and its various OECD suppliers based on data generated by OECD and the Bureau of East-West Trade.
6. A review of the known principal current studies at other institutions indicates no serious duplication regarding the principal approaches, data, and objectives embodied in the proposed study. There is some

potential overlap with the Department of Defense "critical technologies" project.

7. There are useful by-product values to be derived from the proposed study.

Among them are:

- (a) The particular emphasis chosen should stimulate analysis by other researchers along similar lines, and sensitize researchers to the importance of technological details underlying general economic and trade data.
- (b) The material derived from the proposed study can provide a basis for useful policy discussions between the U.S. and other OECD countries.

Appendix A

Outline of Formal Empirical Analysis

The objectives of the formal empirical analysis which will accompany the personal evaluations of interviewed officials and the commissioned reports of sector S&T experts are to: (1) Assist the investigators in the final selection of industry sectors, and (2) Serve as one check on our interpretations of those qualitative findings based on the personal evaluations. The empirical analysis will accordingly be divided into two phases.

1. Phase One

In the first phase the purpose will be to help identify those individual sectors which satisfy the multiple criteria: (1) Soviet priority, (2) Soviet need for Western technology, and (3) plausible U.S. technological lead.

First, drawing largely on successive annual volumes of Soviet foreign trade statistics (Vneshniaia Torgovlia SSSR), we will track the changing pattern of Soviet reliance on OECD as opposed to CMEA sources of various manufactured product groups. Such a study will give us some hint of evolving Soviet priorities and needs for specifically Western technology. Unfortunately, as already mentioned, such a study must be carried out at a much higher level of aggregation than we would like.

Second, we will examine the changing pattern of OECD "high technology" trade flows to the USSR over the past decade. This will involve, first of all, a careful review and evaluation of the definitions of "high technology" or "research intensive" products utilized by, inter alia ECE (1976), OECD (1970), Beitel (1976), Kravalis et al (1979) and Zaleski (1979). Trade data, at the four- and five-digit SITC level, is available from successive issues of OECD, Series C and possibly for 1978 from unpublished sources at BEWT.

This examination of recent trends in OECD "technology-intensive" trade flows towards the USSR will provide a further basis for sector selection.

Third, the changing pattern of U.S. market-share in OECD exports of each technology intensive product to the non-CMEA region will be examined. The same data sources as those mentioned in the preceding paragraph will be used. Although the particular pattern of U.S.-based multinational corporation investment and intra-firm trade flows affects these rest-of-world market-shares, the trends in U.S. shares will give us some additional evidence regarding the evolving pattern of relative U.S. competitiveness in high technology products of particular interest to the Soviet Union.

2. Phase Two

Once the industrial sectors have been selected, the second phase of the formal empirical analysis can begin. This phase will coincide with the interviews of government and industry representatives and the commissioning of short evaluative reports on the comparative state of U.S. science and technology in the several sectors. In this second phase the empirical focus will be on a narrower group of products believed to correspond to some extent to the targeted industrial sectors. The position of the U.S. among OECD exporters of these products to the USSR will be evaluated by reference to the U.S. share in OECD exports to the world more generally. For most if not all products we would expect a certain market share "shortfall" for the U.S. in trade with the USSR. Trends in this shortfall will of course reflect the impact of changing Soviet preferences (among competing suppliers of the "same" product, or among different products making up the product group), changing U.S. export control policies, other differential policy changes, and so forth.

We would like to examine changes in relative U.S. performance in these products over time so as to help us evaluate the other information being

gathered regarding changes in the U.S. technological edge, if any. Unfortunately, we cannot realistically hope to undertake a formal econometric study of this issue. This is because comparative data are not available on real trade flows for most of the SITC 7 product groups. Furthermore, it would be impossible to obtain precise quantitative observations on most of the independent variables (credit policy, export control policy, etc.). [See Wolf (1972, 1973, 1977).] Given the limited number of products being examined, however, we will be able to interpret to some extent our calculated changes in trade-share patterns on the basis of inter alia, published changes in the U.S. Commodity Control List, and discussions with export control and Export-Import Bank officials.

This second-stage analysis should yield additional information which will assist in our evaluation of the relative uniqueness of U.S. technology and also the extent to which the U.S. is competitive in the "non-technological" aspects of technology exchanges with the Soviet Union.

Appendix B

Materials Involved in Case Study on Aluminum Technology

Contents

1. Statement of agreement between Pechiney and U.S.S.R.
2. Letter to aluminum companies requesting comments
3. Letter received from one aluminum company representative
4. (awaiting letter promised by second aluminum company)

Summary of Pechiney-U.S.S.R.
Agreement in Aluminum Industry

The original agreement of several years ago called for Pechiney to construct an anode plant in the U.S.S.R. In addition, there is now under construction a plant to produce alumina. There is a reason to believe that the logical next step is to construct a plant for the fabrication of aluminum, though no agreement has been completed on this subject.

This appears to put Soviet production capabilities at the same technical level as most western countries. In principle, the technologies involved in the Pechiney agreement could have been made available from Alcoa or Alcan, for example -

As a further consequence of the Pechiney-U.S.S.R. joint activities, Pechiney has obtained a license from the U.S.S.R. on a casting process which Pechiney believes is superior to similar processes in the west.

Dear _____:

We have a research grant from the State Department to evaluate the relative importance to the U.S.S.R. of direct technical exchanges with the U.S. This requires some judgments about availability of U.S. technology relative to available foreign technology.

As one example for a feasibility study, we are using the aluminum industry. On a recent European trip, I had some discussions about the status of such exchanges between the U.S.S.R. and Pechiney-Ugine-Kuhlmann. A brief summary of the general scope is attached.

I would very much appreciate your comments, which should include judgments of your colleagues as well, on several issues raised in my summary:

1. Do you agree with the statements made, namely:
 - a. that this agreement puts Soviet production capabilities at the same technical level as most western countries?
 - b. that the technologies involved could have been made available from other sources?
2. Do the Soviets have, via licensing, plant construction, joint venture or other, access to the latest state-of-the-art in any or all phases of aluminum production technology, from alumina through metal?
3. Are there particular areas of strength or uniqueness in U.S. aluminum technology relative to other OECD countries?
4. Would these unique technological strengths be made available to the U.S.S.R.?
5. Are there any particular areas where the U.S.S.R. has unique strengths, and would a commercial relationship make these available to the U.S. or any other OECD country?

I am contacting others in the industry for the same types of comment. Any final written analysis will be general, with no company comment identified by name. You would, of course, receive any report, which would be a public and unclassified document.

We are initiating programs that touch on interactions between technology and foreign policy, and this is the first to be funded externally. Your cooperation will be very helpful.

Best regards.

Sincerely,

Herbert I. Fusfeld

1979 October 12

Dr. Herbert I. Fusfeld
Director
Center for Science and Technology Policy
New York University
Graduate School of Public Administration
329 Shimkin Hall
Washington Square
New York, New York 10003

Dear Herb:

Your October 1 letter requested information on U.S.S.R. aluminum technology. I am repeating your questions and listing brief comments.

1. Do you agree with the statement made, namely:
 - a. that this agreement (for purchase from Pechiney of anode and alumina technology) puts Soviet production capabilities at the same technical level as most western countries?

The completion and satisfactory operation of this technology should put that part of Soviet production in the range of the technical level of Western countries.

My understanding is that the contract for a smelting plant has not yet been awarded. While we feel technology is superior to that of Pechiney, this distinction is within a competitive range.

- b. that the technologies involved could have been made available from other sources?

The technologies were available from at least French and United States interests.

2. Do the Soviets have, via licensing, plant construction, joint venture or other, access to the latest state-of-the-art in any or all phases of aluminum production technology, from alumina through metal?

The Soviets do have access to much of the state-of-the-art of aluminum production. Certain specific areas which may, however, have significant impact, such as computer technology, may be restricted. The exact status of these details is not clear at this time.

1979 October 12

3. Are there particular areas of strength or uniqueness in U. S. aluminum technology relative to other OECD countries?
4. Would these unique technological strengths be made available to the U.S.S.R.?

The great strength of the U. S. aluminum technology is that a large fraction of it represents state-of-the-art construction through an extensive program of modernization by most American aluminum companies. Another virtue of the U. S. system is the extensive integration and depth of technological experience. These strengths are not readily transferable but could in time result naturally.

U. S. has considerable research effort on technology not yet brought to commercialization. The decisions on making this available to the U.S.S.R. or other OECD countries would be faced at a later date.

There is a complete understanding of aluminum technology through the reduction process at the very top of the Soviet technological/scientific hierarchy. However, transferring this information to an effective operating plant is their greatest weakness. In other words, what they are buying from the Western World is time.

5. Are there particular areas where the U.S.S.R. has unique strengths, and would a commercial relationship make these available to the U. S. or any other OECD country?

The most publicized area where U.S.S.R. has a unique strength is in electromagnetic casting. Whether or not this is superior to other casting procedures available in this country remains to be demonstrated. The Soviets have had considerable experience in producing alumina from nepheline syenite. This technology has not found acceptance in other countries.

The Soviets have a vast number of research workers in metallurgy, including aluminum. Governmental subsidies give strength to the industry. I have expected for some years that there would be significant new improvements from this activity. At this time, I am not able to identify them.

The prospects of a scientific exchange with the Soviets is less than enticing--negotiation with the Soviets is always a "win-lose" situation, rather than the "win-win" situation you would hope to have in a scientific exchange.

Sincerely yours,

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